Agriculture
Canada

Publication 1862/E

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**Agriculture Canada Publication 1862/E**
available from
Communications Branch, Agriculture Canada
Ottawa, Ont. K1A 0C7


Cat. No. A53-1862/1991E ISBN 0-662-18469-6
Printed 1974 Revised 1991 4M-05:91

Previously published as 1526/E under the title
*Irrigated pastures for cattle in western Canada*

Produced by Research Program Service

Également disponible en français sous le titre
*Pâturages irrigués dans l'Ouest canadien*

## Contents

## Main steps in producing irrigated pasture

- Sow good seed of adapted varieties
- Seed at shallow depth on well-prepared land
- Control weeds from seeding time on
- Choose a grazing system that suits your class of stock
- Harvest the spring surplus as hay or silage
- Remove seed heads by mowing
- Irrigate lightly and often
- Fertilize regularly
- Do not allow your stock to overgraze a pasture
- Control insect pests of livestock

## Introduction

In western Canada, a good, irrigated pasture can produce 25 or more times as much forage per hectare as native grassland and 7–10 times more than cultivated dryland pasture. With irrigation, forage production is dependable over the season and from year to year, and you can choose the forages best suited to your soil conditions and type of livestock. With a heavier concentration of livestock, supervision and care of the animals are easier, and the potential financial return from a given area of land is greater; but these benefits have a price. The capital costs of irrigation equipment and land shaping can be high, and more fencing and watering facilities may be required. More money may have to be spent on fertilizers and weed control, and the timing of necessary management practices will become more crucial. The greatest potential is on good, well-drained soils where the water supply is unrestricted throughout the season. Economic studies have shown that under such conditions the financial returns from irrigated pasture can exceed those from most field crops. River flats also offer excellent potential, although the water supply is less reliable in some cases and the soils may have a low water-holding capacity. They may require more frequent irrigation than upland soils. Pastures also may have an advantage on less-favored sites where one of the many forage species that will grow in western Canada can be selected for the particular conditions of the site. Thus, on hilly or rocky sites, on moderately salt-affected soils, or where the water supply for irrigation is intermittent, pasture might be a better alternative than cultivated crop production. The level of production of an irrigated pasture will depend on the potential of the site, the forage varieties sown, and the effectiveness of the management applied. The level of success in an operation will depend about equally on the total amount of forage produced and the efficiency with which it is used.

## Carrying capacity

Carrying capacity of irrigated pasture cannot be stated as precisely as it is on native grassland because management has a great bearing on total forage production and the efficiency of its use. Under irrigation, forage stands are usually heavier, allowing grazing animals to consume their forage allotment without traveling as far. This condition is desirable for young animals, as it enables them to grow faster, but mature animals will consume more forage than they need; thus the carrying capacity of the pasture will be below its potential. Another important difference is that good management of native grassland requires that about 50% of the forage be carried over into the next year. On irrigated land, grazing control is necessary only to maintain vigorous plants and to ensure that the livestock have easy access to feed.

Practical experience has shown that a carrying capacity of about 14–15 animal-unit-months per hectare is a reasonable expectation. One animal-unit is equivalent to a 450-kg cow, or equivalent, consuming 12 kg of forage dry matter daily. Table 1 lists animal-unit equivalents and the

Table 1 Animal-unit equivalents* and carrying capacity of irrigated pasture for different classes of livestock

| Class | Animal-unit equivalents | Number of head per hectare (mid May to mid September) |
|---|---|---|
| Bull | | |
| medium frame | 1.50 | 2.5 |
| large frame | 1.70 | 2.2 |
| Cow† | | |
| medium frame | 1.00 | 3.6 |
| large frame | 1.20 | 3.2 |
| Yearling steers, heifers | 0.67–0.80 | 4.5–7.0 |
| Weaned calves | 0.60 | 6.0 |
| Horse | | |
| yearling | 0.75 | 5.0 |
| 2-year-old | 1.00 | 3.6 |
| >2-year-old | 1.50 | 2.5 |
| Sheep or goats | | |
| ewe† or doe† | 0.20 | 18 |
| rams or bucks | 0.25 | 15 |
| Weaned lambs or kids | 0.12 | 30 |

* One animal-unit is a 450-kg cow, or its equivalent, consuming 12 kg of forage dry matter.
† With or without nursing calf, lamb, or kid.

number of animals that can be supported on irrigated pasture for 4 months from mid May to mid September. Management practices, such as the type of forage sown, haying, ensiling, and manipulation of the herd, can affect carrying capacity. The effect of increasing the stocking rate is usually to increase total animal product per hectare and reduce production per animal. Either result might be desirable, depending on the objective of the operation.

## Forage species and mixtures

Grasses are the basis of most pastures because they are generally durable and predictable. Legumes, such as alfalfa and clovers, are important too. They increase the nutritional value of the forage and have the advantage of being able to use nitrogen from the atmosphere, thereby decreasing the need to buy nitrogen fertilizer. Several grasses and legumes can be considered for irrigated pasture.

### Grasses

Grasses are sometimes described as being hay or pasture types. The difference is partly in how tall they grow, but it has more to do with where their vegetative growth originates. Pasture-type grasses maintain a vegetative growing point near the soil surface where it is unlikely to be removed by a grazing animal. New leaf growth comes back quickly after grazing. In hay-type grasses the vegetative growing point is elevated up the stem as the plant grows, eventually reaching a height at which it can be grazed off. New growth after that time must come from buds below the ground, and the pasture takes longer to recover from grazing. Although both types of plants are useful for grazing, they require different management.

*Orchardgrass* This grass is very aggressive, easy to manage, and grows back quickly following grazing. At Lethbridge, yearling steers gained about 115 kg each, during a 4-month grazing season, on orchardgrass pastures stocked at seven head per hectare. In addition, 1.12 tonnes of hay per hectare was harvested. Use a hardy variety to reduce the risk of winterkill.

*Meadow bromegrass* Meadow bromegrass recovers quickly from grazing. It is more winter-hardy and drought-tolerant than orchardgrass, but possibly lower yielding. It has a chaffy seed and sometimes is slow to become established following sowing. Coated seed, which is much easier to handle and can produce a stand faster, is available.

*Italian ryegrass* This ryegrass is fast-growing, palatable, and highly digestible. Although short-lived, it can be used to great advantage in mixtures or for short-term pasture. Sown in early spring, it provides excellent pasture from early July until late fall. If winters are mild, or if there is good snow cover, it can be used for 1 or 2 more years.

There are also annual and winter annual types of ryegrass. The Westerwold's type produces seed and dies in the year of seeding.

*Reed canarygrass* Reed canarygrass is noted for its tolerance to flooding. It produces high yields of forage and is very winter-hardy. At Lethbridge it was easy to manage as pasture and was only slightly inferior to orchardgrass in producing gains on yearling steers. Newer, low-alkaloid varieties are more palatable than the standard types.

*Intermediate wheatgrass and pubescent wheatgrass* These wheatgrasses are moderately drought-tolerant but respond well to irrigation. They begin growth early in spring and make excellent early season pasture. They are hay-type plants (as is smooth bromegrass). In the 3 weeks following heading, they produce few new leaves, which can mean a severe shortage of pasture during the first 3 weeks of July. These grasses are especially useful where the supply of irrigation water is uncertain.

*Kentucky bluegrass* Kentucky bluegrass is an old but very reliable pasture grass. It is seldom sown alone because it is slow to establish except at very high seeding rates. When added to a mixture it will establish a presence in the pasture and will gradually fill in spots that would otherwise be bare or weedy. It gives permanence to a pasture in which some of the other grasses might be winter-killed. Ewes and lambs did well on bluegrass pasture at Lethbridge. Feeder cattle made satisfactory gains provided they were not forced to use all the grass available to them. Where high intake is not required, such as for dry cows, bluegrass pasture is excellent.

*Tall fescue* Tall fescue is useful where the content of salt in the soil is too high for orchardgrass. Use it for the entire pasture or sow it in strips along a canal or in field depressions. It is less palatable than some grasses and might not be well used where the animals have a choice.

*Meadow fescue* Meadow fescue is not commonly used because it is short-lived and has no outstanding qualities. The seed is usually relatively cheap, however, and it can be used to partially replace some other grasses in times of high seed prices.

*Meadow foxtail and creeping foxtail* These foxtails are useful for low-lying land that is subject to spring flooding. On cold soils they will produce the first green grass of spring; they continue to make fair pasture into the fall. Creeping foxtail has good tolerance to soil salinity. The seed is light and fluffy and very difficult to handle in its natural state. Coated seed is available. Do not confuse these grasses with the weed foxtail barley.

*Smooth bromegrass* Smooth bromegrass is best used in a hay–pasture combination. As pasture, its regrowth is too slow to provide continuous grazing under irrigation.

**Legumes**

Pure stands of forage legumes can be grazed but it is more common to aim for a mixture of half grass and half legume. If the legume seed is well inoculated with nitrogen-fixing bacteria at the time of sowing, it is likely that a 50% legume–grass pasture will need no additional nitrogen fertilizer. Besides enhancing the protein content and digestibility of the forage, the legume could contribute nitrogen annually at about 170 kg/ha. Some legumes cause bloat in cattle and sheep, whereas those that do not are classed as "bloat-safe."

*Alfalfa* Alfalfa is easily established and contributes significantly to a forage mixture even when seeded at 2 kg/ha. Under intensive grazing it will not persist beyond 3 or 4 years. Creeping-rooted varieties may have some advantage, although they do not have the disease resistance required for some situations. Death loss from ruminant bloat is a risk that some managers will not want to take (see "Bloat").

*White clover* White clover or ladino clover has been used as a pasture legume, but it has lost favor because dependable hardy varieties are not available. Also, its abundance in the pasture fluctuates greatly with the year and the season, making forage yield less predictable. White clover can cause bloat.

*Cicer milkvetch* Cicer milkvetch has quality characteristics similar to alfalfa but it produces 30% less forage. It has a creeping habit (Fig. 1), is completely hardy, and is potentially long-lived. Its major advantage over alfalfa is that it is bloat-safe. Average daily gains of yearling steers on cicer milkvetch pasture were 30% higher than those of similar steers on orchardgrass. Although total gains per hectare were about the same, the cicer milkvetch had the advantage of not requiring additional nitrogen fertilizer. A disadvantage is that many cicer milkvetch seeds are slow to germinate and establishing a stand can be discouraging. With time, the creeping habit can compensate for a poor initial stand.

*Sainfoin* Sainfoin, another bloat-safe legume, yields about 10% less than alfalfa but does not compete well in a heavy stand of grass. It establishes easily but could be short-lived under heavy grazing (Fig. 2). Average daily gains of yearling steers on sainfoin pasture were 34% higher than those of similar steers on orchardgrass. Stocking rates must be conservative on sainfoin pasture to give the plants ample time to recover between grazings.

*Birdsfoot trefoil* Birdsfoot trefoil grows well on acid soils and produces excellent-quality pasture when sown with adapted grasses. Although it is bloat-safe, it has not been grown extensively on most western soils.

### Mixtures

Grass mixtures are used to extend the life of a pasture, to maintain yields over a longer season, and to form a sod. A legume can be added to supply free nitrogen from the air and to increase the protein content of the forage. The legume should constitute 40–50% of the forage mix.

Using the forages described it would be possible to concoct thousands of mixtures, many of which would be extravagant, unsuitable, or indistinguishable from one another in the field. Recommendations given here are based on research and field experience.

Seeding rates are based on seed size, speed of germination, and vigor of the young seedlings. Sowing 25–30 seeds per 30 cm (1 foot) of row is usually enough to form a good stand (Fig. 3). In seed mixtures the proportions must be right or the more aggressive species will prevent the slower ones from becoming established. One kilogram of orchardgrass has eight times as many seeds as 1 kg of meadow bromegrass. Seeding rates must be adjusted for the difference. Relative seed prices might warrant adjustments or substitutions from time to time, although seed costs are a small part of the total cost of establishing and operating an irrigated pasture project.

## Recommended mixtures and seeding suggestions

In the five suggested mixtures (1–5) that follow, rates of seeding of the various grasses have been adjusted to take into account great differences in seed size. Changing the proportions from those listed could lead to domination of the pasture by one grass to the detriment of others that have

**Fig. 1 Each of these cicer milkvetch plants was produced from one seed.**

**Fig. 2 Sainfoin is well liked by cattle but requires special management for good production.**

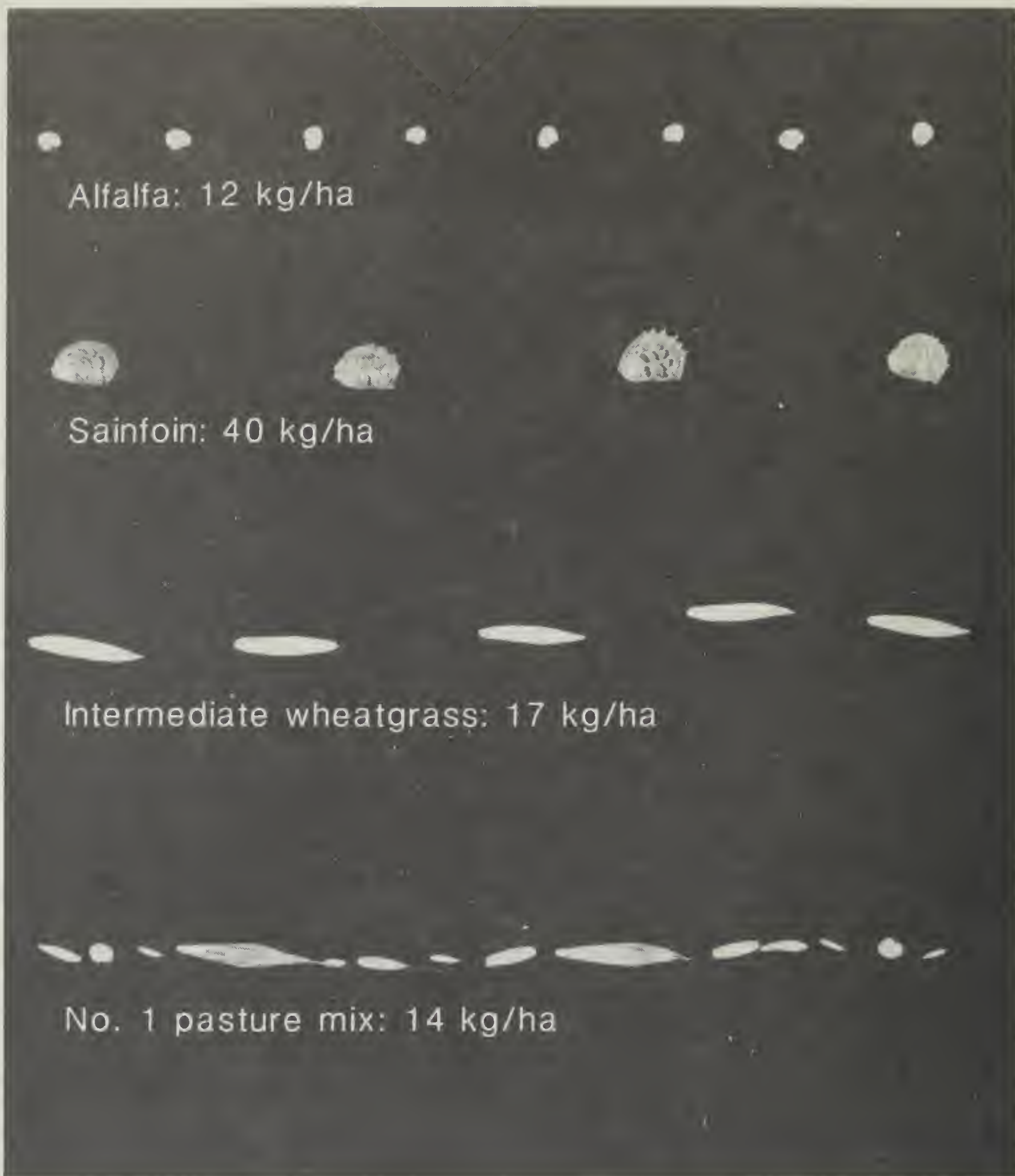


**Fig. 3 Seed spacing, when sown in rows 15 cm (6 in.) apart, at usual seeding rates. (Seeds shown actual size.)**

a specific role to play. Percentages suggested are by weight of seed. In suggestions 6–8, certain species are suitable for particular conditions. Suggested seeding rates are a minimum for a good stand under average conditions.

1. Long-term mixture, suited to a wide range of climatic conditions but only for well-drained, nonsaline conditions:

| | |
|---|---|
| Cicer milkvetch | 25% |
| Meadow bromegrass | 45% |
| Orchardgrass | 17% |
| Italian ryegrass | 10% |
| Kentucky bluegrass | 3% |

Seed at 13 kg/ha (12 lb/acre).

This mixture is bloat-safe. If you are not concerned about bloat, alfalfa can be substituted for all or part of the cicer milkvetch. With good development of the legume, nitrogen fertilizer requirements should be minimal.

2. Long-term mixture using sainfoin rather than cicer milkvetch:

| | |
|---|---|
| Sainfoin | 60% |
| Meadow bromegrass | 24% |
| Orchardgrass | 4% |
| Italian ryegrass | 10% |
| Kentucky bluegrass | 2% |

Seed at 25 kg/ha (22 lb/acre).

The high proportion of sainfoin is necessary because the seeds are large and there are fewer per kilogram.

3. Simple mixture for medium term:

| | |
|---|---|
| Orchardgrass | 75% |
| Italian ryegrass | 25% |

Seed at 12 kg/ha (11 lb/acre).

This mixture will be cheaper to sow, but, for high yields, it will require nitrogen annually at 150–200 kg/ha. The Italian ryegrass might not live beyond the 2nd year, but the orchardgrass will provide a complete cover. Severe winter-killing of the orchardgrass could occur in some years, so use a hardy variety. Legumes will not persist in competition with a vigorous stand of orchardgrass.

4. Short-term, high-legume, bloat-safe mixture:

| | |
|---|---|
| Sainfoin | 95% |
| Orchardgrass | 5% |

Seed at 40 kg/ha (35 lb/acre).

This mixture could provide excellent pasture for 4–5 years or longer if it were not grazed too closely. The orchardgrass must be limited in the seed mixture to allow the sainfoin to compete. Nitrogen fertilizer should not be required.

5. Mixture for use where irrigation water is short:

| | |
|---|---|
| Sainfoin | 70% |
| Intermediate or pubescent wheatgrass | 30% |

Seed at 32 kg/ha (28 lb/acre).

With heavy use this mixture might not survive more than 4–5 years. When grazed only in early summer and again from mid October into winter, some stands have been productive for more than 15 years.

6. Seed suited to high water table and periodic surface flooding:

Reed canarygrass (low-alkaloid type) at 7 kg/ha (6 lb/acre)

or
Creeping foxtail or meadow foxtail (coated seed) at 13 kg/ha (12 lb/acre).
Apply nitrogen fertilizer to maintain yields. Either grass can become a serious weed in irrigation waterways. Use meadow foxtail for wet areas close to irrigation ditches.

7. Seed suited to slightly saline soils:
   Tall fescue at 11 kg/ha (10 lb/acre)
   or
   Creeping foxtail (coated seed) at 13 kg/ha (12 lb/acre).
   Apply nitrogen fertilizer to maintain yields.

8. Seed for annual pasture:
   Italian ryegrass at 11–22 kg/ha (10–20 lb/acre).
   Although a good stand of Italian ryegrass can be established with the lower rate of seeding, the pasture will not be ready to graze until several days later than pasture seeded at the heavier rate. Unless seed is very high-priced, the heavier rate will be good value. High-quality forage will be available from early July until freeze-up, and there is a good chance of a 2nd year of grazing. Consider a mid-season application of nitrogen fertilizer.

## Pasture management

### Establishing the stand

Start with a clean seed bed. A few annual weeds are of little consequence but irrigated pasture is not a cure for a perennial weed problem. Allow time in spring for a crop of weeds to germinate so they can be destroyed by shallow cultivation or by herbicide application before you seed (see “Weed control”). May is the best month for seeding, but, if fall is more convenient, it can be done just after mid August. Before seeding, pack cultivated land firm enough so that footprints barely show in the soil. You can also seed directly into clean stubble without cultivating. Place the seed 1.5 cm deep and pack on top of the rows by using a press drill or by pulling a packer. You can use a companion crop of grain to protect the soil from wind erosion and to obtain a cash return in the year of seeding. Seed the grain first, at half or less of the usual rate, and then seed the forage at right angles to the grain. If you do not use a companion crop, a pasture seeded in spring should provide some grazing by early August. If you use a companion crop and harvest the grain, do not expect to use the pasture before June of the following year. The companion crop could be grazed. Irrigate for the forage seedlings, not for the grain crop.

Special machinery for seeding forages is available but a grain drill will also work well. You can use the grain box for most seeds, although it might be necessary to mix cracked wheat, bran, or something similar with the very small seeds. Since drills differ there will be some trial and error in arriving at the correct setting. With a row-spacing of 15–23 cm, try the setting that will deliver wheat at 54 kg/ha (three-quarters of a bushel per acre). Depending on the drill and the seeds being sown, you might have to adjust up or down from there. Be sure the drill setting is open enough to allow a constant, free flow of seed. If your drill has a clean-out gate on the seed cup, it will help to lower it one notch for large-seeded grasses. For chaffy seeds, such as bromegrass and meadow foxtail, the use of coated seed will improve the flow through the drill. Do not harrow either after seeding with a press drill or after packing.

An alternative method of seeding is to broadcast, harrow, and pack. This method can produce a good stand provided that seed distribution is uniform and that the surface soil is kept moist for a week through rain or irrigation. Drilling the seed into the soil to a depth of 1.5 cm and packing over the row is a more reliable method.

## Irrigation

Pastures need about 60 cm of water during the growing season. Thus, where rainfall is only 15 cm you need to apply 45 cm of irrigation water. The most important point about irrigating a pasture is that water must be applied often and in small amounts. After seeding, light irrigations that keep the surface soil moist will ensure establishment within 2–3 weeks. On established pastures, apply 5–8 cm of water at a time, five or more times during the growing season. Grasses get most of their water from the top 30 cm of soil. In a sandy loam, the soil might be able to store only 4–6 days supply of available moisture to this depth at the peak demand time of the season. Irrigate the pasture after it has been grazed and after any required mowing or fertilizing has been done. Irrigate again as needed to ensure that the plants do not suffer moisture stress before the next round of grazing begins.

Choose a grazing system that suits your land and management scheme. Intensive grazing requires a lot of cross-fencing, which complicates the moving of wheel lines or centre pivots. Flooding on properly leveled, border-diked land (Fig. 4) fits in well with pasture rotation but it is too labor-intensive for most operations. The problems and possible solutions are discussed further under “Rotational grazing.”

## Fertilizing

On grass pastures you will need to apply nitrogen fertilizer to maintain high yields. If you maintain adequate soil moisture in the upper part of the root zone you can expect an economical response to nitrogen applied at 50 kg/ha in mid April and again around June 1, July 1, and August 1. You might be tempted to eliminate the April application, reasoning that it would only add to the spring surplus. But, although the surplus is increased, the spring application gives by far the most economical response of the season. In one experiment each kilogram of nitrogen applied in April gave a yield increase of 24 kg of grass dry matter, a June application gave 12 kg, and the July and

**Fig. 4 Flooding with a border-dike system is the cheapest method of irrigating if the land has a gradual, uniform slope.**

August applications gave 7 and 3 kg, respectively. If any application is omitted it should be the August one.

Pastures that contain at least 50% legume should not need nitrogen fertilization, which means substantially lower production costs. In the economic study referred to, the highest net return was from a pure legume pasture (sainfoin), even though it had a lower carrying capacity than the grasses. Phosphorus, and possibly other nutrients, might be required from time to time but their need should be determined through a soil test. The grass–cicer milkvetch mixture might require added nitrogen fertilizer during the first year or two while the milkvetch is developing.

The legume content of the pasture may decline over the years. If it drops below 25%, you will likely get a response to nitrogen fertilization. Ammonium nitrate is a good source of nitrogen where fertilizer is applied to the soil surface as granules. Do not surface-apply urea, because the loss of nitrogen to the atmosphere could be high. Other fertilizers can be applied to the soil surface, or through the irrigation system.

## Weed control

Control weeds prior to seeding by using herbicides or by cultivating. Check provincial recommendations to be sure that a herbicide will not leave a soil residue harmful to forage seedlings. After seeding, watch for weeds and be prepared to take action. A few scattered weeds will pose no threat but a heavy population will seriously retard development of the pasture. Most weed seedlings can be controlled with appropriate herbicides. An alternative is to let the weeds grow until they are tall enough to mow. One mowing is usually enough.

In an established pasture, weeds might be only a symptom of poor growing conditions or inadequate management, and not be the main problem. Poor irrigation practice, inadequate fertilization, prolonged close grazing, and grazing while the soil is wet from irrigating are the most common causes of increased weediness.

Common weeds in irrigated pastures are foxtail barley, Canada thistle, and dandelion. Foxtail barley usually occurs on poorly drained or saline soils. Frequent mowing helps to check its growth, but mowing is not a permanent cure. Foxtail barley will not be a problem if you can rid the soil of excess salt and water and apply fertilizer to promote vigorous grass growth. If you cannot improve the soil, use a forage mixture that is adapted to the specific conditions (see "Forage species and mixtures"). Where Canada thistle is a problem it probably was present when the pasture was seeded, although it will invade poor pastures. The best control is spraying with a herbicide and mowing. Refer to provincial recommendations. Dandelions will invade pastures although they will be restrained by vigorously growing grasses. In experiments it was possible to remove dandelions from a grass pasture with heavy applications of a herbicide, but the total forage yield did not increase following treatment. The nutritional value of dandelions to cattle was comparable to that of the grasses in the pasture.

### Mowing

Periodic mowing to remove grass seed heads and to control some weeds is an important part of intensive management (Fig. 5). If you aim to maximize feed intake, the forage will have to be easily accessible to the animals and highly digestible. If the animals are forced to eat stemmy growth, both the forage and the animals will be less productive. Mow to remove grass seed heads in June. Mow the first grazed pastures after their second grazing of the season. Pastures grazed later in the rotation may be mowed after their first grazing. Only one mowing of each rotation field will be required to control seed heads. Areas harvested once for hay or silage will not need further mowing. If the mixture includes alfalfa, sainfoin, cicer milkvetch, or birdsfoot trefoil, set the mower at a height that will remove grass seed heads while cutting off a minimum of the legume. The legumes will make faster recovery growth and persist longer if they are not mowed. Weedy areas should be mowed as frequently as necessary for control.

### Rotational grazing

For high-producing animals, such as feeder cattle or dairy cows, your likely objective will be to maintain maximum intake of highly digestible

**Fig. 5 When a large number of seed heads have formed, mow the pasture after it has been grazed.**

feed. Such feeding will require close control over the quality of the forage in the pasture and its allocation to the animals. The growth of forage dry matter does not always correspond to animal requirements (Fig. 6). Early in the season, forage growth is rapid and exceeds the animals' ability to consume it. Later in the season, forage growth rate slows down and will be insufficient to meet the animals' requirements.

The ultimate method of maximizing intake is to cut the forage daily and deliver it to confined animals. Daily cutting is expensive, however, and impractical for most operations. The next best method of control is to use fences to isolate portions of the pasture where the forage is at the preferred quality stage and confine animals to it for a short time. By using a movable electric fence, pasture can be allocated for any period of time, down to a 1-day or even half-day schedule. However, only experienced managers should use such a system as the timing of operations becomes more complicated with a large number of fields. With fixed fencing the total grazing area can be divided into four to six fields, each of which will be grazed in turn. The animals will spend an average of 4–7 days on each pasture and return to a previously grazed field in 3–6 weeks, depending on the time of year and the forage mixture.

Timing of rotations is essential to maximizing pasture productivity (Figs. 7 and 8). If cattle are allowed to graze forage too close to the ground, post-grazing recovery of the pasture will be delayed. If cattle are removed

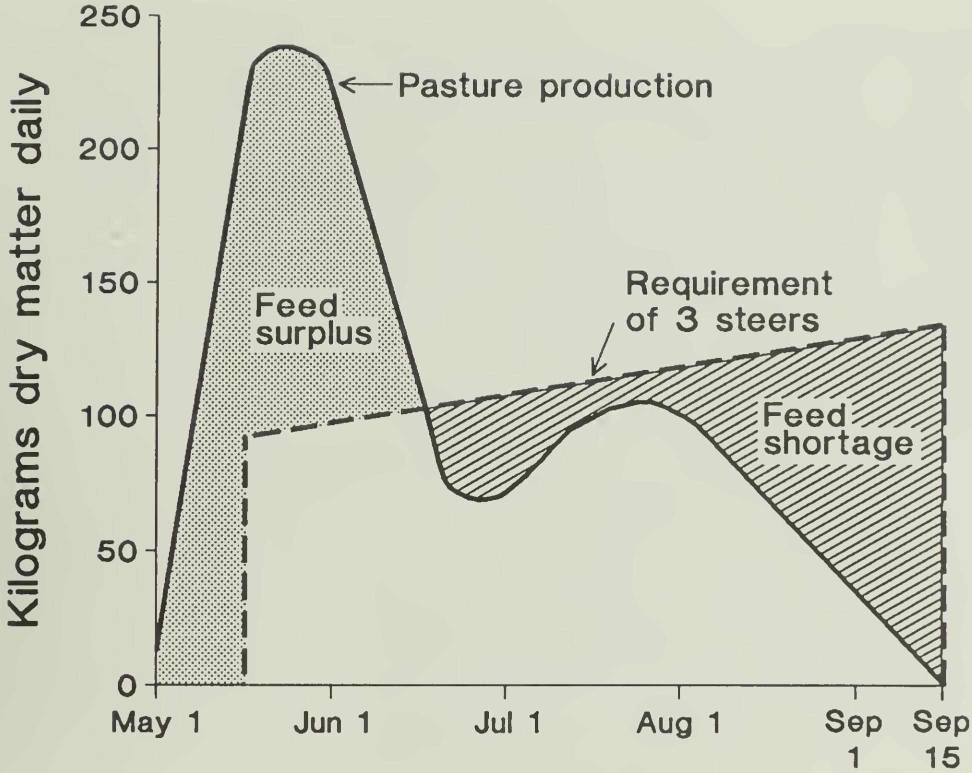


**Fig. 6 Forage growth and animal requirements are not always in balance. The best solution to this problem is to harvest the early surplus and store it as hay or silage for feeding later in the summer.**

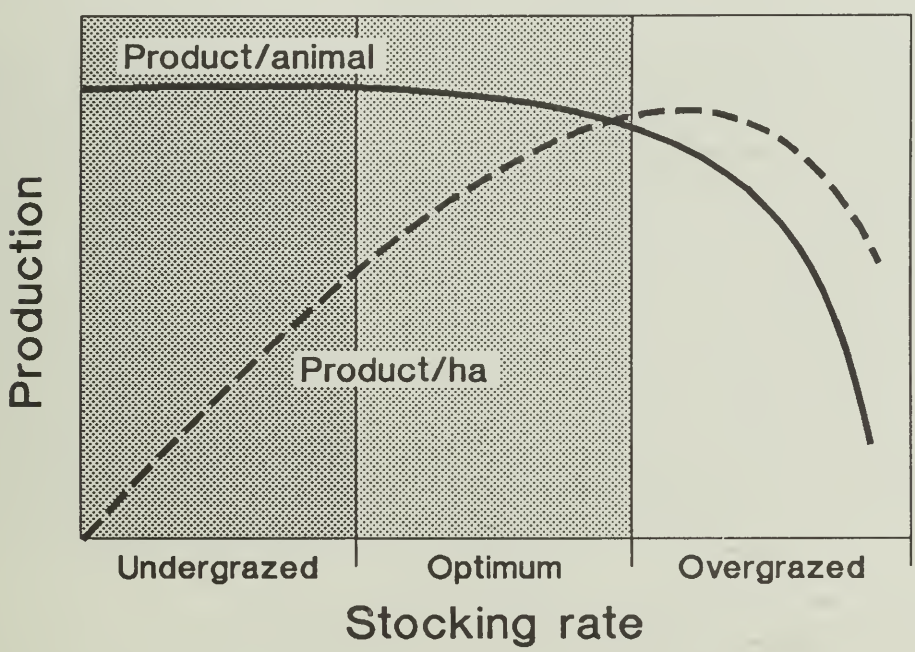


**Fig. 7 Effect of overgrazing and undergrazing on forage and animal production.**

from pastures too soon, the forage will become over-mature before the next grazing cycle. Most of the recommended grasses can be grazed to a stubble height of 5–10 cm and regrazed when growth has recovered to 15–20 cm. Be sure to leave 8–10 cm of stubble as winter cover. Alfalfa and sainfoin should be left with a higher stubble and not regrazed until growth recovers to 25–30 cm. To preserve cicer milkvetch in a mixture with grasses, allow the pasture a rest period of 5–6 weeks between grazings. Plan to have at least 8–12 paddocks, each of which will be grazed three times during the season.

Not everyone will aim for maximum intake of high-quality forage because some classes of stock, such as dry or mother cows, do not require it, and because the intensive management required might not be available. A three-field or even a two-field rotation is better than no rotation at all. At the very least, confine the animals to a smaller portion of the pasture in spring and early summer when grass growth is rapid. If they have access to surplus pasture at that time of year they will waste up to one-third of the forage. An alternative is to have the stock with the lowest nutrient needs (cows after peak lactation) follow animals with the highest nutrient requirements (feeder cattle, Fig. 9) in the rotation.

To irrigate with wheel line or centre pivot, arrange a means of getting the system through the fences by leaving gaps in the fence to accommodate pivot wheels and towers. Animals can be constrained by installing electrified, spring-loaded steel rods across the gaps, by using Texas gates, or by other inventive means such as placing plywood painted with white and black stripes on the ground across the openings. If the paddocks are separated by an electric fence on a spool and ratchet, the wire can be dropped to the ground to let the wheels pass.

Managing the spring surplus is vital because two-thirds of the forage will be produced before mid July and only one-third after that. Special measures are necessary to avoid extravagant waste of the forage surplus in early summer. To maintain the same herd size throughout the season, set aside one-third to one-half of the pasture area for harvesting as hay or silage once, in early June. After the harvested portion has regrown, then graze the entire pasture for the remainder of the season. You will get the best animal response by continuing a rotation system, but, if you are not geared to that kind of management, you could graze the entire pasture area as one unit. However, by grazing all the pasture as one unit you not only will sacrifice yield but also will reduce the life of your pasture through excessive damage caused by grazing on wet soil. If you have the flexibility in your operation you can stock at a rate of 5–7 animal-units per hectare in late May and early June and remove one-half of the animals to another feed source, such as annual forage, community pasture, or native rangeland, or otherwise dispose of them for the balance of the season.

It is important to keep plants from maturing because leaf growth may stop entirely while seed is being produced. If grasses start to head and the pasture is not to be grazed immediately, cut the area for hay and the regrowth can be grazed in about 3 weeks. If seed heads are sparsely distributed, mowing the heads is sufficient.

**Fig. 8 Close grazing in the fall may lead to winterkill in forage crops.**

**Fig. 9 To make rapid gains, feeder cattle should always have access to plenty of grass so that their feed intake is kept at a maximum.**

In an economic study on irrigated pastures at the Lethbridge Research Station the highest net return per hectare occurred when the stocking rate was adjusted throughout the season, in accordance with the amount of forage available, and all the forage was grazed. The second highest return occurred when the spring surplus was harvested as hay or silage and fed back later. The second option is the only practical one for most operations. Harvesting the surplus and selling it as hay on the open market was a distant third in the options considered.

## Animal management

### Water and minerals

Supply plenty of fresh, clean water to all livestock on pasture. Where rotational grazing is used, provide a lane from each field to give the animals access to water, or place the water supply in the centre of the pasture where the rotation fields meet. Table 2 gives examples of the water requirements for cows.

Livestock also need minerals. A mineral supplement should contain 10–15% of both phosphorus and calcium and should be mixed half and half with cobalt-iodized salt. The levels of trace minerals included in the salt mixture should reflect the deficiencies that are common in forages grown in your area.

Intake of the salt–mineral mix should be monitored to ensure that it is adequate. Mature beef cows will generally consume 80–120 g of salt mixture per day. If intake is outside this range, adjust the proportion of salt to mineral so that the intake of mineral will be sufficient as specified by the manufacturer. Prevent deficiencies and avoid excessive intake, which is wasteful. If the fields where the animals are grazing are large, locate the water and minerals at least 400 m apart so that the animals are encouraged to move over the entire area available to them. Keep the mineral mix protected from rain (Fig. 10).

Table 2 Water requirements for beef cows at different environmental temperatures

| | Water (L/day) | |
|---|---|---|
| Frame size | at 25°C | at 32°C |
| Small | 20 | 50 |
| Medium | 30 | 65 |
| Large | 45 | 80 |
| Milk production | | |
| average | 25 | 30 |
| superior | 45 | 55 |

**Fig. 10 Protecting the mineral mix from the weather is important. The mineral feeder shown is mounted on ball bearings; the weather vane turns the opening away from the wind.**

## Shelter

Animals need shelter from the sun during hot weather. Steers may gain up to 0.2 kg more each day when they have shelter. If no trees are available, provide a simple, inexpensive structure, as long as it is large enough to accommodate all the animals and to allow air to circulate freely. Mature shelterbelts along the southern and western edges of fields can provide protection for cattle.

## Insect control

Cattle bothered by flies, mosquitoes, and other insects suffer considerably and their production is reduced. For example, uncontrolled horn flies may reduce gains of yearling steers by 25%. Fly control is most easily achieved by using insecticide-impregnated ear tags. These ear tags are effective against horn and face flies if used according to the manufacturer's recommendations. However, there is potential for a buildup of an insecticide-resistant fly population, particularly if not all animals are tagged. Where resistance is a problem, cattle oilers may be used for a few seasons to break the cycle of resistance.

## Supplemental feeding

High-producing animals may benefit from supplemental concentrates while on pasture. Supplements can be used to increase the production or to extend the feed supply when the stocking rates exceed the carrying capacity of the pasture.

Yearling steers self-fed rolled barley on pasture will each consume daily 5–6 kg, which will result in an additional daily gain per animal of 0.5 kg. Cattle allowed free access to grain will reduce forage intake and waste feed. Therefore, it is often better to limit feed concentrates either by hand-feeding daily, which is very labor-intensive, or by mixing salt with the grain. Each steer will consume daily about 0.5 kg of a 1:1 salt–grain mixture. Unfortunately, it is difficult to control accurately intake with added salt as cattle gradually adapt to high salt concentrations. Water requirements are greatly increased and the salts are excreted in the urine, contributing to salt buildup in the soil. Benefits from grain supplementation are generally greatest after mid July when pasture quality begins to decline.

Nursing calves can be creep-fed on irrigated pasture. However, the additional growth observed in creep-fed calves is often insufficient to pay for the cost of the creep feed. There are other indirect advantages to creep feeding. Dams of creep-fed calves generally maintain better body condition than if no creep feed were provided. A beef cow in excellent body condition requires 20–30% less feed during the winter than a thin cow. Also, creep-fed calves should adapt more quickly to feedlot diets than calves not receiving creep feed.

## Bloat

Alfalfa and clover are legumes that may cause bloat in cattle and sheep. Deaths resulting from bloat are thought to be about 2% where alfalfa or other bloat-inducing legumes comprise less than one-half of the forage mixture. Many livestock producers feel that the value of the legume outweighs the risk for animals of ordinary value, but not for animals of high value. However, if you have only a small herd, the possibility of a devastating loss has to be considered. Cicer milkvetch, sainfoin, and birdsfoot trefoil are legumes that are considered to be bloat-safe.

You can control the growth of legumes by regulating the grazing height. Continuous close grazing favors white clover; light grazing suppresses it. For alfalfa the opposite is true: close grazing quickly eliminates it from the pasture. A high rate of nitrogen fertilizer encourages the growth of grass, which in turn crowds the legume out of the pasture.

Bloating is caused by gas that is blocked in the rumen. The gas causes the rumen to swell, especially on the left flank of the animal. As the gas pressure increases, the animal gasps for breath and becomes greatly distressed. In acute cases the animal may die in a short time unless the gas pressure can be relieved quickly.

To relieve bloat, first try using a stomach tube. If tubing gives no relief, a trocar and cannula inserted 15–20 cm in front of the hip bone and about 8 cm below the loin area may be effective. In an emergency, an incision into the rumen may be the only effective treatment.

A commercial product called Poloxalene has been found to be reasonably effective in controlling bloat caused by alfalfa. The treatment is practical for animals that get daily supplementary feed but less effective where the product is added to a salt block. Drenches with defoaming agents may also help. Other drenches such as turpentine, coal-tar derivatives, and household detergents are sometimes used as treatments, but all drenches should be used with caution. Certain ionophore feed additives, such as monensin, are used to improve animal growth rate. These products have been reported to reduce bloat but are not registered for that purpose.

Before animals are turned out on alfalfa or clover pasture, make sure they have been well fed with other feed. It may also help to have dry feed available in the pasture. Chronic bloaters should be slaughtered. A more detailed discussion of bloat can be found in *Bloat in cattle* by R.E. Howarth et al. (Agric. Can. Publ. 1858/E).

## Some facts about irrigated pastures

- A good irrigated pasture produces 7800 kg of dry forage per hectare (7000 lb/acre) from mid May to mid September; an average pasture produces 5600–6700 kg/ha (5000–6000 lb/acre).
- In 4 months the amount of forage dry matter eaten by hand-fed yearling steers was equivalent to 2.4% of their body weight.
- On grazed pastures 15–35% of the forage produced is wasted. Waste is minimized when the June surplus is harvested and stored as hay or silage.
- On reasonably well managed pasture, yearling steers gain about 0.5 kg (1 lb) for every 4.5 kg (10 lb) of forage dry matter produced.
- Gains of yearling steers were reduced by as much as 25% when horn flies were uncontrolled on pasture.
- On good orchardgrass pasture, the average carrying capacity has been seven yearling cattle per hectare for 110–120 days, each animal gaining 100–108 kg (220–240 lb). Besides, it usually has been possible to harvest 1 tonne of hay.
- One hectare of good grass and legume used for hay and pasture can feed 2.5 cow–calf units (8 tonnes of dry matter) for 1 year. The weaned calf needs additional feed.
- The effect on yield of irrigated grass pasture of an application of nitrogen fertilizer (50 kg/ha) was almost gone after 40 days. To sustain rapid growth of grass in early summer, apply nitrogen fertilizer every 3–4 weeks. This rate differs from results obtained from dryland pasture, where the effect lasts longer.
- Cattle graze about 8–10 h each day. If forage is in short supply, the cattle eat less during the hours spent grazing and therefore produce less.